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DO CONTAMINANTS HARM ESTUARINE HABITAT QUALITY? JUST ASK THE FISH!

For decades, managers have employed techniques such as chemical analyses and laboratory-based sediment toxicity tests (with standard test species) to predict the effects of contaminants in the Bay. However, the responses of organisms actually living in the Bay are what managers, scientists, and the public care most about. Managers and scientists alike have been frustrated by the lack of consensus on how pollutant effects should be characterized in fish, invertebrates, and plants of the estuary. It is an opportune time for cooperative investigations that will lead to a solution to this problem.

The Pacific Estuarine Ecosystem Indicator Research (PEEIR) consortium advocates the development of an integrated portfolio of contaminant exposure and effects responses using indicator species that are selected for various habitat types. We developed a portfolio of techniques for salt marshes that are integrated within fish (mudsucker, *Gillichthys mirabilis*), invertebrate (shore crab, *Pachygrapsus crassipes*) and plant (cordgrass, *Spartina foliosa* and pickleweed *Salicornia virginica*), indicator species. We performed sediment and tissue chemical analyses and analyzed biomarker responses in these species at five marshes in Northern and Southern California. A comparison to toxicity test responses and benthic population surveys was performed at a more limited number of stations. While the widely used Sediment Quality Triad approach is a useful screening tool, we found that this approach does not predict the range of effects in resident species. Specifically, we noted reproductive impairment in shore crabs and/or ovarian tumors and endocrine disruption in mudsucker fish at two sites where toxicity was either relatively low or nonexistent. We have also developed toxicity identification procedures that can be used to predict what chemicals cause endocrine disruption and other reproductive harm in fish.

Our Resident Species Portfolio approach is a first step in making monitoring of Bay species more practical, and hence minimizing extrapolations inherent in ecological risk assessment of contaminated sediments. Numerous emerging contaminants are being discovered, such as Personal Care Products and flame retardants; techniques are needed to prioritize the contaminants that cause the greatest harm to aquatic life and to help focus regulatory action. Through highly integrated research and improved cooperation between research and management, it will be feasible to create a new paradigm for determining when and how contaminants impair the quality of our estuarine habitat. *This research has been supported by the EPA Science to Achieve Results (STAR) Estuarine and Great Lakes (EaGLe) program through funding to the Pacific Estuarine Ecosystem Indicator Research (PEEIR) Consortium, an integrated team of over 30 Principal Investigators. Pacific EcoRisk performed the toxicity testing cited above in collaboration with PEEIR.*

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FORTY YEARS SINCE BCDC'S CREATION: WHAT DO THE NEXT FORTY HOLD?

The state of the estuary is, literally, California. San Francisco Bay and its Siamese twin, the Delta, both lie within one state jurisdiction. We in California could therefore have planned for both the Bay and the Delta as joined bodies of water that they are. But they are by no means identical twins, and we have not treated them as if they were.

We have made greater progress with the Bay than with the Delta. This year we mark the 40th anniversary of the beginning of the San Francisco Bay Conservation and Development Commission. And this year we note the work of the CALFED Bay-Delta program to resolve some of the most difficult issues in California--how to protect and restore the Delta while simultaneously providing water for agriculture and for the expanding population of urban California.

CALFED needs the same broad public support and understanding that the Save San Francisco Bay Association brought to the campaign to stop the uncoordinated filling of San Francisco Bay in the 1950s and early 1960s. Most residents of the Bay Area now understand the importance and value of the Bay. Unfortunately, most residents of California do not have the same understanding of the Delta.

Nobody can look 40 years ahead and tell us what to expect in the next four decades. But we can already see the shapes of some things to come: the possible effects of global climate changes; the possible effects of rising sea levels; the continuing struggles over water supply and water quality; and the need for better governance of the common resources of the Delta.

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FISH ADVISORIES AND YOU

The Office of Environmental Health Hazard Assessment (OEHHA) issues fish consumption advisories for local water bodies in California. Fish advisories are useful as environmental indicators of water quality, but they need to be put in context as a measure of change in the San Francisco Estuary. The very first fish advisory in California (1971) was for striped bass in the Bay-Delta and advised fishermen to eat no more than one meal per week of striped bass due to mercury in these fish. Pregnant women and children were advised not to eat striped bass. The advisory has been periodically updated as new data became available. In 1994 specific advice was added for fish and shellfish from the Richmond Harbor Channel area based on data for pesticides and other chemicals. And, later in 1994, the current advisory was developed using data from a Regional Board study. This advisory was based on mercury and organic contaminants (e.g., PCBs) in fish species from San Francisco Bay, and recommended that adults should eat no more than two meals per month of Bay fish and no striped bass over 35”. Women and children under six were advised to eat no more than one meal per month of Bay fish, and no large shark (>24”) or striped bass (>27”). The advisory was amended in 1996 to clarify that the same advice applied to striped bass and sturgeon in the whole Bay-Delta area.

Based on the decreasing meal recommendations it may at first appear that water quality in the Estuary has degraded since 1971. Since advisories, and their underlying data, do impact water management and agencies responsible for water quality through the 303(d) list and Total Maximum Daily Load process, it is important to understand these changes. Evidence indicates that in general concentrations of organic chemicals have decreased and that mercury concentrations in fish have remained about the same. Changes in the advisory are due to improvements in analytical methodology and new studies expanding our understanding of the toxicology of methylmercury and other chemicals.

The primary goal of fish consumption advisories is to provide information to the public that they can use to personally reduce exposure and risk to contaminants already in the environment, while still enjoying fishing as a natural resource and health benefits from fish consumption. Advisory awareness through outreach activities is a critical ongoing component for public health and safety because processes aimed at reducing chemical concentrations in fish take a long time.

OEHHA is working to move beyond a focus on monitoring water bodies with known or suspected contamination problems, to identifying fish and water bodies where one can catch and eat more fish, and develop safe eating guidelines for these. This requires a coordinated California program to monitor fish people eat from water bodies where they catch them for a variety chemical contaminants. This would provide a statewide baseline for contaminants, help identify emerging risks, and track trends in water quality as indicated by more fish that can be safely eaten from more water bodies.

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ALIEN AND NATIVE FISH ASSEMBLAGES OF THE LOWER SAN JOAQUIN RIVER WATERSHED

Changes in land and water use in the San Joaquin River watershed, as well as the deliberate and accidental introductions of alien species beginning in the mid-1800s, profoundly changed the aquatic flora and fauna in this region of California. Studies over the last decade in the lower mainstem San Joaquin River and its tributaries have provided much useful information on the fish assemblages of the region and have identified some of the environmental factors associated with their distribution and abundance. This talk briefly summarizes the results of these recent studies, which provide a basis for assessing possible outcomes of rehabilitation efforts.

In a comparison of 20 major rivers across the United States, the lower San Joaquin River had the highest percentage of alien fish species (70%) and the highest percentage of alien fish captured (>90%) based on data collected from 1993 to 1995. Detailed analysis of a comprehensive data set from 20 sites in the lower San Joaquin River watershed sampled during the same time period indicates the presence of four major fish assemblages, with native fishes most abundant in the reaches of tributary rivers just below the large foothill dams. Environmental conditions below the dams were more similar to conditions in the streams favored by many of the native fishes, compared to environmental conditions in downstream reaches. Analysis of annual monitoring data collected from 1987 to 1997 from eight sites on the lower Tuolumne River indicated that the percentage abundances of native and alien fishes captured at a site were associated with springtime flow conditions and distance from the San Joaquin River. Alien fishes accounted for a greater percentage of the catch when flows in the previous year were relatively low and at sites closer to the San Joaquin River. In contrast to the lower San Joaquin River watershed, the lower Sacramento River watershed still supports relatively large populations of native fishes, possibly because the river channels are used as throughput water delivery systems, thus maintaining higher, cooler flows than in the San Joaquin River watershed, where water is diverted from river channels for off-channel uses. These studies suggest some level of predictability in the response of fish assemblages to environmental change. However, there are likely unknown interactions between alien and native fishes, between fishes and non-fish species, and between fishes and environmental conditions, that make uncertain any predictions regarding the outcome of strategies for rehabilitating native fish populations.

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DUTCH SLOUGH: THE PROMISE OF RESTORATION AND THE CHALLENGE OF ADAPTIVE MANAGEMENT

The CALFED Bay Delta Authority together with the State Coastal Conservancy provided $28 million to acquire a 1,166 acre parcel along Dutch Slough in northeastern Contra Costa County for tidal marsh restoration. The parcel was previously levied dairy and ranch land that was slated for development of 4,500 residential units. The California Department of Water Resources has assumed ownership responsibilities and is working collaboratively with the State Coastal Conservancy, CALFED, the Natural Heritage Institute, and the City of Oakley to plan and implement the restoration project within an adaptive management framework. The goals of the project are to: 1) provide shoreline access, recreational and educational opportunities, 2) to restore a mosaic of wetland and upland habitats for native species, and 3) to increase understanding of ecosystem function through an adaptive management approach.

The property is divided into 3 levied tracts that could be separately treated and restored to tidal action creating a unique opportunity to design the restoration project as an adaptive management experiment. The project partners are working with an interdisciplinary group of scientists to physically design the project to test hypothesis regarding the role of marsh plain elevation and associated inundation frequency in 1) avian utilization, 2) growth and survival of juvenile salmon and splittail, 3) colonization of submerged aquatic vegetation, 4) production and flux of methyl mercury and dissolved organic carbon, and 5) the role of vegetation in freshwater marsh plain accretion and slough channel evolution. Different portions of the project site will be restored to different marsh elevations in an attempt to isolate the role of marsh plain elevation in these various processes.

The planning process has revealed several challenges and potential tradeoffs that can arise when designing a restoration project as an adaptive management experiment. Designing an experiment into the restoration design is an ideal opportunity to learn but can create conflicts between optimal experimental design and optimal restoration design. For example, dividing the restoration site into numerous cells of different elevations could help tease out the role of elevation in numerous ecosystem processes, but fragmentation of the site into smaller cells could reduce connectivity of various habitat types and potentially preclude important scale dependent processes.

Adaptive management presumably implies that managers will change their management intervention if it does not perform as desired. This paradigm makes obvious sense with efforts to manage fishery harvest, cattle grazing, or exotic species, but is more complicated for capital intensive earth moving projects in highly regulated environments. If the initial design does not perform as desired, is it realistic to assume that managers will or should physically modify the Dutch Slough restoration. Or should the Dutch Slough project be viewed as a one time management intervention designed to inform future restorations in the larger Bay-Delta system?

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ELEVATION, INUNDATION, AND VEGETATION: IMPLICATIONS FOR RESTORATION

Tidal wetland restoration efforts have focused on establishing the appropriate elevation for plant colonization, with the assumption that elevation determines inundation rates and other critical factors for plant establishment and growth, including soil redox status and salinity. While elevation is the key factor driving inundation rates, within-site variation due to impoundments, pannes and other features may affect local flooding and draining. Substantial research has evaluated elevational distributions of tidal wetland plants in San Francisco Bay wetlands; however, very little work has directly linked elevation to patterns of inundation across a tidal wetland.

As part of the Integrated Regional Wetland Monitoring Program (IRWM), we evaluated distributions of plant species across six tidal wetlands in the north San Francisco Bay Estuary, working closely with the IRWM Physical Processes Team to connect these distributions to elevation and inundation patterns across each wetland. Plant distribution and elevations were determined at 200-500 locations in each wetland and were related to inundation patterns from three to four water level stations on the marsh plain. Inundation data were collected for approximately one year at each wetland and were also compared to water level data from instruments in adjacent tidal channels.

Patterns of vegetation zonation were apparent from our data, with species showing peaks in distributions across the tidal wetlands. For example, at Coon Island, *Salicornia virginica* had the most widespread elevational distribution, with a number of species occurring at slightly lower elevations, including *Spartina foliosa*, *Typha angustifolia, Bolboschoenus maritimus* (formerly *Scirpus maritimus)*, and *Schoenoplectus acutus* (formerly *Scirpus acutus*). There was substantial overlap and spatial variability in both the elevational distributions and inundation patterns for some of the dominant species, including *S. acutus*, *Schoenoplectus californicus* (formerly *Scirpus californicus*), and *Typha angustifolia.* We found little evidence for critical thresholds for plant distributions across all wetlands. Other factors that are likely to affect distribution include soil salinity (being measured this year), initial vegetation establishment, and competition. With the IRWM Bird Team, we also are comparing vegetation patterns to bird use so that we can evaluate how inundation affects habitat characteristics that are linked to wildlife use. In order to effectively restore tidal wetlands throughout the Estuary it is critical that we better understand the factors that affect both large- and small-scale patterns of plant distributions. There is evidence that minor shifts in elevation and inundation (presence/absence of creeks) can affect plant distributions, and our research will help to further understand these patterns.

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STATE OF THE STEWARDS, A DISCUSSION ABOUT VOLUNTEER EFFORTS.

A panel discussion with four stewards about mobilizing volunteer efforts around the Bay. We will cover issues such as funding volunteering programs, public lands partnerships and techniques to optimize volunteer efforts. We will hear about challenges, constraints and creative solutions. We will discuss the volunteers, who they are and why they donate their time; the numbers of volunteers and hours contributed; how volunteer efforts help leverage resources for successful projects.

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RE-INVENTING THE DELTA: THE CALL FOR A NEW VISION

Only five years after the CalFed Record of Decision was signed, key stakeholders in the water and environmental communities are calling for another new vision for the Delta, one that will endure. Assuming that it is possible to design and implement a long-term plan for an ecosystem as complex and dynamic as the Delta's, how shall we arrive at a durable new vision for the future?

Water, agriculture, recreation and the environment, traditionally identified as the key Delta interests, are well-represented in the statewide debate about the Delta's future and would be expected to help craft the new vision. But where do the dozens of Delta-area special districts, cities and counties, along with local landowners, fit into the process? Not traditionally engaged as stakeholders, Delta-area local governments in six counties are making land use decisions without a common vision and without recognition of the potential impact to unique resources of statewide importance.

The Secondary Zone of the Delta, as defined in the 1992 Delta Protection Act, is urbanizing in response to the same growth and development pressures being experienced throughout the state. A one time largely undeveloped, it has served as the buffer between urban development and the essential resources of the Delta's Primary Zone. But since 1993, local governments have approved development on over 44,000 acres in the Secondary Zone, resulting in 94,000 new residential units (including thousands of new houses behind levees), and thousands of square feet of industrial, commercial and retail space. An additional twelve thousand acres of Secondary Zone farmland (including eight thousand acres designated "prime") have been converted to an urban land use designation between 1990 and 2002.

When all currently approved development is built out, urban land uses in Secondary Zone will have doubled, expanding from one-quarter of the zone's total acreage in 1993 to one-half. With the diminishing ability of the Secondary Zone to serve as a buffer, the Primary Zone will experience increasing "edge" conflicts along its ag-habitat-urban fringe, further threatening the delicate balances of its fragile ecosystem and impacting the continued viability of Delta agriculture.

Science has an important role to play in researching and illuminating the impacts of urban development upon Delta resources. Without scientific data, the politically charged issue of land use in and around the Delta cannot be successfully addressed nor can a durable new vision for the future be achieved. Delta local governments are necessary stakeholders in the visioning process.

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PROGRESS ON PREVENTING THE INTRODUCTION OF EXOTIC SPECIES

Exotic species have altered the species composition, habitats, food webs, population dynamics and other aspects of the San Francisco Estuary. Exotics comprise most of the species, individuals and biomass across many habitats, making this one of the most invaded estuaries in the world. A 1995 review found that hull fouling, ballast water discharges, aquaculture activities and fisheries releases were the most important mechanisms introducing exotic species to the Estuary, with lesser contributions from bait imports, biocontrol releases, restoration activities and others.

Studies have also shown that in recent decades exotics species have been arriving and becoming established the Estuary at an increasing rate, with ballast water discharges responsible for an increasing share of the introductions. This presentation will review the status of efforts to manage the most important mechanisms introducing exotic species into the Estuary and the Pacific Coast, and consider whether significant progress has been made over the last decade in reducing introductions by these mechanisms.

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THE NEXT GENERATION OF RESTORATION PLANNING: LINKING WETLANDS TO WATERSHEDS

Habitat stewards and scientists have been working together to achieve the baylands habitat goals set in 1999. The size of bayland restoration projects has increased, the fragmentation of habitats seems to be decreasing, the suite of target habitats has broadened, and the amount of collaboration on project design and assessment has grown.

This collaboration has fostered new ideas about tracking wetland health and restoration progress. Multi-disciplinary teams of technicians and managers are more likely than before to advise and review the conceptual designs and monitoring plans for restoration projects. This is expected to improve project performance. A three-tiered approach to comprehensive wetland assessment is emerging to support project design and tracking. Regional habitat inventories comprise level 1. Cost-effective rapid assessments of ambient condition and selected projects comprise level 2. Standardized intensive monitoring to address critical concerns and test specific hypotheses comprises level 3. Public information management that enables data sharing among regional centers is also envisioned. The ongoing State Wetland Inventory, the California Rapid Assessment Method, the growing number of intensive monitoring protocols adopted by the Bay Area Wetland Monitoring Group, and the continuing development of the Wetland Tracker for coastal watersheds indicate significant progress toward implementing the assessment framework.

This approach to regional habitat assessment – setting shared goals and developing a tiered approach to tracking progress toward the goals – is being adopted in other regions, including Elkhorn Slough, Humboldt Bay, and the Great Salt Lake Ecosystem. It is also being used to begin integrating the assessments of baylands and watersheds in the Bay Area. Through the Napa Watershed demonstration project, habitat inventories, probabilistic surveys of ambient condition, and intensive assessments of restoration performance are being integrated into a single report of overall wetland health at the watershed scale.

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LESSONS LEARNED: DESIGN GUIDELINES FOR TIDAL WETLAND RESTORATION IN THE BAY

Since the early 1970s, over 45 tidal marsh restoration projects have been implemented around San Francisco Bay, restoring tidal action to more than 2800 acres. More than 20,000 acres is now in active planning and design. There are, as of the year 2005, 33 years of restoration history and up to 19 years of systematic monitoring data from projects in San Francisco Bay. There is now sufficient information from these monitoring efforts, and from ‘snapshot’ observations of other restored sites, to provide guidance on pragmatic practical design questions often encountered in restoration practice.

Funding from the State Coastal Conservancy to The Bay Institute has allowed the evaluation and documentation of this experience to produce a Design Guidelines report. The target audience is all those concerned with practical restoration questions in San Francisco Bay and includes resource management and regulatory agency staff and environmental professionals involved in tidal wetland restoration. Many of these design questions are relevant to resource managers in other estuaries.

We have structured the Guidelines to identify and assess key design issues. We do this by:

1. Explaining our conceptual model of how restored marshes evolve and function based on our own observations and other researchers’ assessments of restored marshes.

2. Describing the planning context used in restoration practice that creates the framework for design decisions and considering site-specific factors as well as geographic variability in the environmental setting and variation in project objectives.

3. Addressing the major design questions that dictate the grading of the site ‘template’ prior to reintroduction of tidal action.

We recognize that restoration practice is still in its infancy, with considerable uncertainties and unknowns. This Design Guidelines report is intended to be a ‘2004 Version’ We anticipate that new insights will be provided in future years by continued monitoring data from restored sites.

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ON THE FRONT LINE OF PREVENTION – CALIFORNIA'S MARINE INVASIVE SPECIES PROGRAM

In October 1999, California enacted the first statewide mandatory ballast water management law designed to prevent or reduce the introduction and spread of nonindigenous aquatic species via ship's ballast into California state waters. While the Program's initial focus was on foreign ballast water management, during the 2003 Legislative session the law was reauthorized and evolving into a multi-faceted program that more comprehensively pursues the prevention of nonindigenous aquatic species via the commercial shipping vector. The program melds education and outreach with enforcement efforts, resulting in compliance rate levels exceeding 90%. Stakeholder involvement has become integral to policy development. Technical Advisory Groups (TAGs) consisting of scientists, regulators, and shipping industry representatives, are regularly convened to inform management strategies. Two TAGs are currently working towards the formulation of recommendations on new issues for the program; ballast water treatment technology standards; and management of ANS through vessel fouling. In areas where priority information gaps have been identified, the program provides limited logistical and financial support. Projects have included onboard testing of ballast water treatment technologies, research on open ocean exchange verification, and research on the vessel fouling risk for the U.S. Pacific coast. Finally, the program maintains a database that has tracked ballasting practices of vessels entering California since 2000. The system contains a valuable time series of data that can be used to advance the management and research in the field.

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USING BIRDS TO ASSESS RESPONSE TO HABITAT RESTORATION IN THE SAN JOAQUIN VALLEY

PRBO Conservation Science has been monitoring songbird populations using multi-tiered methods in restored and remnant riparian habitat in major watersheds of the Central Valley for the past 13 years. Objectives include identifying existing areas of high bird diversity for protection and enhancement, establishing habitat relationships, and quantifying population response to changes in habitat including pre- and post- restoration, as reflected in the distribution, abundance and demographic parameters of a broad spectrum of species. In addition, we study stopover use and weight gain during migration, and site persistence during winter. Results are used to guide specific restoration practices and develop quantitative performance measures and biological objectives for bird populations at various spatial scales across the Central Valley. At mature sites along the San Joaquin River nest substrate selection for 3 species was positively correlated with forb cover and shrub cover underlining the importance of planting and managing for understory species and structure. The novel focus on restoring understory on a 3 year-old restoration sites on the San Joaquin National Wildlife Refuge has influenced the return of two locally extirpated species: the Yellow Warbler (from 0 to 14 nesting pairs) and the first pair of Least Bells' Vireos breeding in the Central Valley in over 60 years. While abundance of birds at restored sites show promising increases in abundance and species diversity during spring, fall, and winter, nest success of many species, especially in remnant forests remains problematic and may be too low to sustain populations over time in the absence of restoration of floodplain dynamics or other conservation actions.

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CURRENT STATUS OF NON-NATIVE SPARTINA CONTROL IN THE ESTUARY

At the outset of the 2005 Spartina control season in the San Francisco Estuary, the ISP mapped and delineated 132 individual areas of varying sizes infested with non-native Spartina. In sum, over 1,200 net acres of Spartina were targeted for control, spread over roughly 11,000 acres of tidal marshland. At least 32 of these infested sites are restored marshlands, and many of the other sites are remnant or historic marshes that are assumed to serve as native propagule sources for planned restoration efforts in the Bay.

Building upon the knowledge gained through the successes and setbacks of the 2004 Spartina control season, the 3rd International Spartina Conference held in San Francisco in November 2004, the ISP's 2003 Spartina Monitoring Report, and work to date in other Spartina-infested areas worldwide, the ISP determined that a aggressive targeting of all Spartina-infested areas within the Estuary for control in 2005 was warranted. This control effort was preceded by a comprehensive survey of the infested habitats for populations of endangered California clapper rail and an analysis of the potential impacts of the various proposed treatment methods on each individual site. The results of this work informed the timing and strategy of treatment planning efforts, while providing pre-treatment baseline information as a comparison for post-treatment effects on the systems involved.

The results of the 2005 Spartina control season will be presented, including the areas and acreage treated, successful (and unsuccessful) methods and approaches, areas of continued concern, and outlook for the 2006 and 2007 control seasons.

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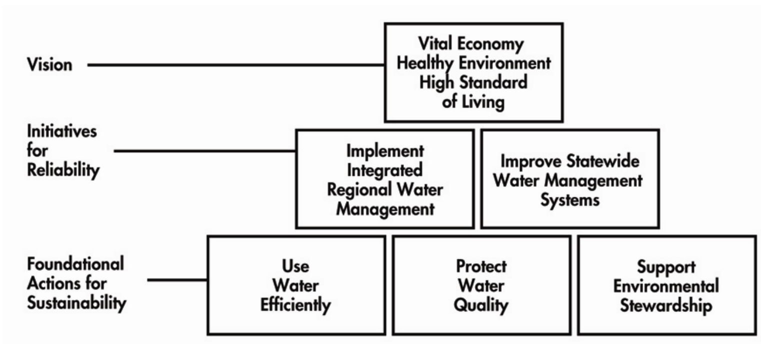
CALIFORNIA WATER PLAN 2005: A FRAMEWORK FOR ACTION

The Department of Water Resources (DWR) has changed the process for preparing the *California Water Plan* and the information it contains. The Water Plan has become a strategic document that describes the role of State government and the growing role of California's regions in managing the state's water resources.

In preparing *Update 2005*, DWR sought the participation of California's water communities, responded to new State laws, and, by working with an Advisory Committee, developed a new approach to planning California's water future. DWR significantly expanded the public forum for updating the California Water Plan by establishing the 65-member Advisory Committee and a 350-person Extended Review Forum and seeking input from 2,000 other interested members of the public.



Water Plan 2005 provides California's water communities with a vision, mission, and goals for meeting challenges of sustainable water use through 2030 in the face of uncertainty. It has recommendations for decision-makers, resource managers, water suppliers, and water-users. And for the first time, the water plan includes a proposal for carrying out its recommendations. The plan provides a Framework for Action to stimulate progress now to ensure a sustainable and reliable water supply in 2030. This framework will focus and prioritize State government's water planning, oversight, and technical and financial assistance on several foundational actions and initiatives. The Framework for Action also identifies a number of essential support activities needed to accomplish its foundational actions and initiatives.

Water Plan 2005 contains water data, information, and studies used to develop the strategic plan. It outlines today's water challenges and evolving water management responses; it presents benefits and costs of 25 resource management strategies; it reports regional water conditions and activities; it considers multiple future scenarios and their water demands; and it describes an approach to improve data management and analytical tools for future plan updates.

Water Plan 2005 is summarized in the *Highlights* document and presented in five volumes: (1) Strategic Plan, (2) Resource Management Strategies, (3) Regional Reports, (4) Reference Guide, and (5) Technical Guide. The final *California Water Plan Update 2005* will be published in fall 2005.

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CALIFORNIA 2025: PUTTING THE ESTUARY INTO THE BIG PICTURE

This talk will provide an overview of the findings of the recent study, *California 2025: Taking on the Future* (Ellen Hanak and Mark Baldassare eds., Public Policy Institute of California, June 2005), to provide a context for thinking about the funding challenges and strategies in support of the San Francisco Estuary.

The purpose of the *California 2025* study is to consider whether the state is facing a growth and infrastructure crisis and how to best think about planning for the future. It looks at these critical topics: population and economic growth; patterns of infrastructure financing; current estimates of infrastructure needs; governance and institutional challenges for planning; issues of equity; and the public's perceptions of the future; preferences regarding schools, water and transportation; and willingness to pay higher taxes of fees to fund those preferences.

Some findings particularly relevant to the Estuary concern the overall picture for public investment and the specific picture for water resources. Overall, California's levels of public investments are largely on par with those elsewhere in the nation. In recent years, however, the state's contribution to this spending has been predominantly funded through general obligation bonds. High projected debt ratios suggest that alternative sources may be needed over the years ahead.

In the area of water supply and quality, the study finds that the state's numerous water and wastewater utilities are largely on track to fund anticipated capital needs. Moreover, utilities have a straightforward way to raise revenues through user fees, which are still low relative to median income. The biggest challenges, therefore, relate to environmental programs, including the restoration of the San Francisco Estuary. To date, these programs have largely been funded with state bonds. As existing bond monies dry up, the question of appropriate contributions from water users will become increasingly important.

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HOW THE ECONOMIC ENGINE OF THE BAY AREA IS CHANGING: IMPLICATIONS FOR ENVIRONMENTAL STEWARDSHIP

The Estuary Conference focuses on a number of environmental performance indicators for the San Francisco Bay. However, these indicators—as well as our ability to influence them—are shaped in important ways by some larger considerations, including especially the region's job growth, economic performance, and the ability of our public bodies to balance economic and environmental stewardship.

This presentation will discuss the evolution of the Bay Area's economy, with a particular focus on Silicon Valley. It will highlight key trends since the "dot com" collapse and discuss a newly emerging paradigm for the region in a globalizing economy. Finally, the presentation will discuss the implications of these trends for our continuing environmental stewardship.

The presentation will draw on research published annually in the *Silicon Valley Index*, a pioneering research effort launched by *Joint Venture: Silicon Valley Network* in 1995. The *Index* provides a suite of economic, environmental, and social indicators that provide a foundation for analysis and decision making.

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RESPONSE OF BIRDS TO VEGETATION, HABITAT CHARACTERISTICS, AND LANDSCAPE FEATURES IN RESTORED MARSHES

Bird species' presence and function in a given marsh are determined by physical and biotic factors, as well as demographic constraints imposed by their life histories. Collaboration with research teams in other disciplines, working at the same locations, has greatly enhanced our ability to study interactions of birds with vegetation, which provides food for avian prey and substrate for nesting. As part of our multi-disciplinary studies, we are investigating how bird populations may be limited or influenced by landscape-level factors, hydrological and geomorphic processes. We are building models that examine how heterogeneity of physical processes, plants, habitat, and landscape affect the structure and ecological function of the tidal marsh bird community. While not an exhaustive list, specific variables we examined, included salinity, vegetative species composition, distance to specific landscape features (such as pond, channel, urban, bay, etc.), and a variety of channel metrics (channel order, linear density, areal density, etc.).

Using spatially predicted models, we are able provide resource managers with current information on species abundances and distributions within restored and mature marshes and assess the conservation and restoration efforts within the region. In addition, these analytical tools allow us to locate areas of the marsh or types of marsh where our predictions are less certain (i.e., where the model performance is poor), and therefore will benefit from additional sampling and research.

In this paper we present the model results as well as spatial predictions for several sites in San Pablo and Suisun Bays. The PRBO adaptive monitoring protocol, which is currently being developed for the tidal marshes in the San Francisco Estuary, will provide a powerful, yet cost-effective approach to monitoring avian populations.

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LOOKING TO THE FUTURE: WHERE ARE WE HEADED IN THE NEXT TEN YEARS?

Thanks to passage of several voter-approved state bond acts in recent years, public agencies have been able to work in partnership with non-governmental organizations, citizen groups, and private foundations to acquire over 30 thousand acres of historic baylands in the San Francisco Estuary. Planning and engineering is now well underway to determine how to restore these areas to provide habitat for endangered species, waterfowl, shorebirds, and other native wildlife, to improve water quality, and to provide wildlife-oriented recreational opportunities to the public. During the same period, much attention has been focused on the need to "look up" into the watersheds and out "into" the ocean to address water quality, species protection, flood management, hydrology, ocean conservation and other issues if we are to meet restoration and protection goals for the estuary. With the creation of the California Ocean Protection Council, the development of new incentives to integrate water resources management on a regional scale, and a greater interest in working collaboratively with new partners, we have an unprecedented opportunity to take a more seamless look at how to manage the estuary, its watersheds and the ocean resources to which it is connected.

This talk will examine where we are headed in the next ten years with respect to funding the implementation of these and other restoration projects. Estimated to cost over $300 million in the next decade alone at a time when federal funding is on a downward projection, new bond acts and local/regional funding initiatives will be required. In addition, it will identify how research being conducted for the South Bay Salt Ponds and by the Ocean Protection Council might alter our thinking about how we restore baylands, direct new funding, and manage water resources.

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SAN FRANCISCO BAY JOINT VENTURE: SUCCESSES IN PROTECTING AND RESTORING THE BAY

The San Francisco Bay Joint Venture (SFBJV) is a partnership of non-governmental organizations, utilities, landowners, and agencies working to acquire, restore and enhance wetlands on San Francisco Bay and on the coasts of San Mateo, Marin, and Sonoma Counties. The San Francisco Bay Joint Venture is one of the twelve wetland habitat Joint Ventures operating under the North American Waterfowl Management Plan (NAWMP), a Congressional agreement between the United States, Canada, and Mexico. The SFBJV Implementation Strategy, *Restoring the Estuary*, was completed and approved by NAWMP in 2001.

With Bay land goals based on the Habitat Goals Project, SFBJV goals include:

- Acquisition: 63,000 acres of Bay habitats, 37,000 acres of seasonal wetlands, and 7,000 acres of creeks and lakes (107,000 acres total)
- Restoration: 37,000 acres of Bay habitats, 7,000 acres of seasonal wetlands, and 22,000 acres of creeks and lakes (49,000 acres total)
- Enhancement: 35,000 acres of Bay habitats, 23,000 acres of seasonal wetlands, 22,000 acres of creeks and lakes (80,000 acres total).

The focus of SFBJV for the past 4 years has been implementation of projects toward the established goals. Analysis of accomplishments since the founding of SFBJV (as of June 1, 2005) indicate that significant progress toward the established acreages goals for acquisition, protecting 43,000 acres (40% of the total goal and 63% for tidal wetlands), restoring 5,023 acres (10% of total goal), and enhancing 4,982 acres (6% of total goal). These accomplishments are being analyzed to correspond with each habitat type to help assess future focus and priorities of SFBJV and locations in focal area of San Pablo Bay, the South Bay, Central Bay, and the coast.

Based upon the above information, the SFBJV Restoration Strategy/Technical Committee has recommended a shift in focus toward restoration. This emphasis would include funding, planning for restoration, and monitoring and assessment to provide guidance in the habitat types needed to accomplish the vision and goals established in *Restoring the Estuary.* A new project tracking data system has been developed by Ducks Unlimited for SFBJV to provide partners access to a structure that enables them to track the progress of each project and to analyze each project and accomplishments in the context of the overall goals. The NAWMP assessment has also identified additional monitoring and evaluations needs to determine whether a) wintering conditions in San Francisco Bay contribute to the continental scaup and scoter declines; b) the overall quality of Bay habitat for wildlife; c) the impacts of human disturbance on waterfowl and other wildlife species; d) impacts of converting habitats to other types of wetlands habitats on wildlife; e) relationships of migratory wildlife that use SFBJV habitats to the habitats within other joint ventures.

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NORTH BAY RESTORATION: NAPA SALT PONDS AND HAMILTON AIRFIELD

Two major restoration opportunities are beginning to come to fruition in the North Bay: the Napa Salt Ponds and Hamilton Airfield.

In 1994, the Cargill Salt Company ceased the production of salt in the North Bay and sold almost 10,000 acres of ponds and adjoining lands to the State of California for $10 million. The Coastal Conservancy, California Department of Fish and Game, and U.S. Army Corps of Engineers have completed a Feasibility Study for the reduction of salinity and restoration or enhancement of habitats in the former salt ponds. Some of the inactive salt ponds currently provide significant habitat for fish and wildlife, while the salinity levels in others exceed that which is beneficial to wildlife. The project objectives for the Napa Salt Ponds are: (1) to restore large patches of tidal habitats in a band along the Napa River, in a phased approach, to support a wide variety of fish, wildlife, and plants, including special status species, and (2) to effectively manage water depths and salinity levels of remaining ponds to benefit migratory and resident shorebirds and waterfowl. Restoration will begin this fall with the commencement of tidal restoration of 3 ponds (3,000 acres) and enhancement of 3 additional ponds. The work will be conducted by Ducks Unlimited using grant funds from the Wildlife Conservation Board and the California Bay Delta Authority. A potential addition to the Project is the use of recycled water to dilute bittern, a salt production by-product, in partnership with the Sonoma County Water Agency.

The first phase of the Hamilton Wetland Restoration Project will provide 620 acres of restored tidal and seasonal wetlands at former Army airfield and adjacent taxi areas on San Francisco Bay in the city of Novato, Marin County, California. It is anticipated that he the project will receive all permits by the end of September 2005. The Corps of Engineers and State Coastal Conservancy are planning to add the adjoining State Lands Commission parcel and the Bel Marin Keys V property to the project to expand the wetlands project size to almost 2,500 acres. The phased approach will be used to complete the design and construction tasks in conjunction with the availability of land and dredged material. This wetlands restoration project will advance the beneficial reuse of dredged material from San Francisco Bay as part of the Long Term Management Strategy (LTMS). The U.S. Army Corps of Engineers, San Francisco District is the lead federal agency for the project and the California State Coastal Conservancy is the local sponsor.

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LOW DISSOLVED OXYGEN IN THE TIDAL SAN JOAQUIN RIVER: MECHANISMS AND MODELS BASED ON LONG-TERM TIME SERIES

The Stockton Deep Water Ship Channel, a stretch of the tidal San Joaquin River, is frequently subject to low dissolved oxygen conditions and annually violates regional water quality objectives. Hypoxia is most common during June-September immediately downstream of where the river enters the Ship Channel. Underlying mechanisms are examined here using the long-term water quality data, and the efficacy of possible solutions using time-series regression models.

At the annual scale, ammonium loading from the Regional Wastewater Control Facility has the largest identifiable effect on year-to-year variability. The longer-term upward trend in ammonium loads, which have been increasing over 10% per year, also corresponds to a longer-term downward trend in dissolved oxygen during summer. At the monthly scale, river flow, loading of wastewater ammonium and river phytoplankton, Ship Channel temperature, and Ship Channel phytoplankton are all significant in determining hypoxia. Over the recent historical range (1983–2003), wastewater ammonium and river phytoplankton have played a similar role in the monthly variability of the dissolved oxygen deficit, but river discharge has the strongest effect.

Model scenarios imply that control of either river phytoplankton or wastewater ammonium load alone would be insufficient to eliminate hypoxia. Both must be strongly reduced, or reduction of one must be combined with increases in net discharge to the Ship Channel. Model scenarios imply that preventing discharge down Old River with a barrier markedly reduces hypoxia in the Ship Channel. Even with the Old River barrier in place, however, unimpaired or full natural flow at Vernalis would have led to about the same frequency of hypoxia that has occurred with actual flows since the early 1980s.

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WATER PLANNING IN THE DELTA
A CASE STUDY IN MANAGEMENT ADAPTABILITY

The concept of adaptive management has worked its way into the interface between water and biological sciences. Adaptive management allows water and biological managers to modify environmental conditions, develop data on the effects of these changes and then adapt operations or standards to reflect the knowledge gained. This works well when the system being evaluated is staying relatively constant. However, recent events in the Bay/Delta Estuary have shown us that this system has changed markedly in the last few years both from an ecological point of view but also from a funding and institutional perspective. The issue now is not so much adaptive management but management adaptability to respond to these changes. Can water and fishery managers change directions as fast as the political and ecological changes around them and adapt their approaches to problem solving fast enough to resolve conflicts?

CALFED has been the institutional pillar upon which we have built today's interrelationships between agencies and programs to protect and enhance both environmental conditions in the Bay/Delta Estuary and to provide the water supply reliability for those who rely on water developed from the Bay/Delta watershed. However, the funding for the CALFED programs has been less than expected and this program is undergoing an extensive review and possible "refocusing" to evaluate its successes and to hone its mission to concentrate on resolution of Bay/Delta conflicts. Most importantly CALFED will attempt to develop appropriate user contributions to the CALFED Programs so that it has sustainable funding.

In the past three years there has been a decline in the relationships between the abundance of many open water fish inhabiting the upper Bay/Delta Estuary and the ecological factors that have historically affected their abundance. This unexpected decrease in abundance of these pelagic organisms has sparked an intensive effort by agency, university and outside scientists to determine the cause or causes. Making water management decisions in light of this uncertainty requires us to be pragmatic and cautious. In addition, the sustainability of the current Delta levees infrastructure has been brought into question by last year's Jones Tract levee failure, funding issues and by scientists studying the long-term subsidence, earthquake probability and prospects for sea level rise due to global warming. Given these questions the State needs to reevaluate what the Delta will look like in the next 50 to 100 years and develop a strategic plan towards that vision.

Water planning in general in California has taken a new shift with the release of the Draft California Water Plan this past spring. Two new initiatives, Integrated Regional Water Management and improving the State's water management system, build upon the principles of increased water use efficiency, improved water quality and environmental stewardship. A Water Resource Investment Fund is needed to help meet California's water investment strategies for the future. A partnership with funding is needed between local and regional entities and the State to meet California's growing water needs.

The environment in which we find ourselves is changing rapidly. It will test our water management adaptability. Our ability to pass these tests will determine our future as a State.

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PROSPECTS FOR WETLAND RESTORATION IN SAN FRANCISCO BAY: A LANDSCAPE ECOLOGY PERSPECTIVE

San Francisco Bay is the largest estuary on the Pacific coast of the United States; its wetlands provide crucial habitat for a wide range of species, and have a long history of impact. The wetland landscape here is a complex mosaic of remaining historic wetlands, centennial marshes, recently restored wetland sites, and potentially restorable diked bayland sites (farms, former salt ponds, and managed and unmanaged seasonal and perennial wetlands) – all arranged in one of the state's largest urban areas. This diverse mosaic separating bay from upland is crucial in many ways to the future of the SF Bay Area: for example, these wetlands are an important component of the bay's ecology, and they are part of the natural open space valued by a highly urban population.

While it has long been recognized that wetlands are ecotonal features between upland and open water, we also think of this complex of wetlands in the greater SF Bay as wetland patches with ecotonal areas between them, and displaying within-patch variability that is important for species (bird, fish, mammal, etc.) diversity and survival, and other wetland functions. A landscape ecology approach is useful for setting the stage for large-scale wetland restoration in the Bay; the approach incorporates multiple scales and considers interactions between patches and flows between and across ecotones and patches. This paper discusses this approach, and presents examples of the SF Bay wetland landscape, and discusses how landscape ecological principles such as adjacency, connectivity, heterogeneity and spatial configuration can be useful guiding principles for future restoration.

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SEARCHING FOR CLUES TO DECLINES IN THE DELTA PELAGIC FOOD WEB

The recent decline in abundance of several species of fish in the Sacramento-San Joaquin Delta has prompted an unprecedented cooperative effort aimed at identifying the causes of the decline. Public and media attention to this decline has been great: for the first time in my career, I have seen the picture of a copepod on the front page of a newspaper.

In this talk we discuss how the cause(s) of the decline could be determined. This is an extraordinarily difficult problem, exacerbated by the intense pressure on agency scientists and their university colleagues to find “the answer.” One way to begin delimiting the problem is to investigate where changes have occurred across each of several dimensions. The most obvious of these are space and time, and these give clues: the declines have occurred generally in freshwater since 2001, more in Suisun Bay and the Delta than in Suisun Marsh. Another key dimension is species: only some of the species present within the spatio-temporal box of concern have declined, while others have not. Contrasting life histories may give a clue to why some have declined and others not.

An additional dimension is trophic position. The species that have declined include the copepod *Pseudodiaptomus forbesi* and several species of fish. *P. forbesi* is important food for at least some of these fish species during summer, implying a causal link. Chlorophyll concentration, used to indicate the availability of food for copepods, has not changed over the same period. The lack of decline in chlorophyll would indicate that the breakdown is occurring in the population dynamics of the copepods, but phytoplankton species composition has also changed. *P. forbesi* seems to have a very low reproductive rate, so a small decrease in food consumption could have a big impact on abundance. Our ongoing work on population dynamics may shed some light on these issues.

The next dimension is “stressors”, i.e., factors that might have negative impacts on populations. Although there is a strong tendency to point fingers at recent changes in water export patterns in the south Delta, temporal changes in actual volume exported do not correspond with the observed population changes. Other potential stressors include anthropogenic contaminants and toxic releases from the cyanobacteria *Microcystis aeruginosa*, which has bloomed in the Delta since 1999. These stressors have their own suite of dimensions, and the extent of their potential effects on the foodweb may be difficult to determine, especially in retrospect.

Figuring all this out will take more than expanded monitoring, although there are some key system elements not being monitored. We need to measure processes such as growth, fecundity, and sensitivity to contaminants will be required if we are to go beyond status and trends. These efforts are beginning, but must be adaptive if results are to be achieved soon.

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STATUS OF CHINOOK SALMON AND STEELHEAD IN THE CENTRAL VALLEY AND SAN FRANCISCO BAY

To help guide recovery planning for threatened and endangered chinook salmon and steelhead in the Central Valley and San Francisco Bay, we are developing biological viability goals for populations and evolutionarily significant units (ESUs) of these species. We infer the historical population structure from a combination of historical records and GIS-based habitat modeling, develop simple criteria for population status based on genetic and demographic models, and assess historical and current spatial structure of ESUs in relation to sources of catastrophic risk using tools from graph theory. The winter-run chinook salmon ESU consisted of four populations prior to the dam building era; all four were extirpated from their natural spawning range, but are represented by a single population utilizing the tailwaters of Shasta Dam. This population of winter chinook satisfies the criteria to be considered a viable population, but cannot be considered a viable ESU by itself, because it is vulnerable to several catastrophic risks that could easily extirpate the population, and therefore, the ESU. The spring-run chinook salmon ESU is represented by 2 or 3 extant independent populations, and over 20 have been extirpated. Like the winter-run chinook population, the extant populations are probably viable in the short term, but because these populations are quite close together, this ESU is at elevated risk of extinction due to catastrophic risks that would not have threatened the historical ESU with extinction. The situation with steelhead is much more murky. There may have been on order of 80 or more independent populations of steelhead, and much of the spawning habitat used by these populations now appears to be behind impassable dams. It is possible that descendents of the historical steelhead populations persist as resident trout, and new populations may exist in tailwater areas below some dams. Overall, it appears that habitat conditions in accessible areas have improved, as indicated by the improving status of extant populations. More broadly, however, the large majority of historically used habitat is not accessible to anadromous fish, and the presently restricted distribution of the ESUs keeps then at elevated risk of extinction. Further improvements in the status of chinook salmon and steelhead may require access to currently inaccessible habitat.

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ADAPTIVE REAL-TIME MANAGEMENT OF WATER QUALITY IN THE SAN JOAQUIN RIVER BASIN

Adaptive real-time water quality management is a strategy for improving water quality conditions in an impaired water body by providing real-time access to flow and water data, disseminating river assimilative capacity forecasts using computer-based simulation models and implementing control strategies. The technique is particularly relevant to the San Joaquin River Basin where water quality objectives and regulatory constraints on flow and contaminant loads are often in conflict and lead to sub-optimal benign exploitation of river assimilative capacity. In the case of contaminants such as dissolved solids, boron and selenium these inefficiencies have led to frequent violation of Regional Water Control Board objectives, especially during dry and critically dry years. An overview of experiments, conducted over the past decade, and designed to implement and assess the advantages of adaptive real time water quality management is presented. Each of these experiments have been interagency collaborations that have clearly demonstrated that improved cooperation and coordination of agricultural, municipal and wetland drainage return flows with east-side reservoir releases has unrealized potential for improving river water quality. As the Water Quality Subcommittee of the San Joaquin River Management Program we conducted the first phase of experimentation, which concentrated on the main stem of the San Joaquin River and its major tributaries, and continued for a period of five years. During this period a number of supplemental projects were initiated which focused on major contributing watersheds among the west-side tributaries to the San Joaquin River, including selenium affected agricultural land as part of the Grassland Bypass Project and seasonal wetland drainage in CALFED-sponsored projects located in the Grassland Water District and San Luis National Wildlife Refuge. The latest implementation of the adaptive real-time water quality management strategy is contained in the Stockton Dissolved Oxygen TMDL and CALFED Directed Action Project. These projects have, for the first time, created an opportunity for Basin-wide water quality modeling and forecasting to minimize real-time excursions of the dissolved oxygen concentration in the Stockton Deep Water Ship Channel. The long-term goal of this effort is to replace the piece-meal and conflicted TMDL approach to water quality management

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CAN WE RESTORE HEALTHY RIVER FUNCTION ON THE SAN JOAQUIN RIVER?

Can the mainstem San Joaquin River downstream of Friant Dam, the southern Central Valley's complement to the Sacramento River, be restored to support a species assemblage that includes anadromous salmonids? It is a challenging task for a river that has experienced dramatic physical and hydrologic changes since the 1850's, because the cumulative effects of dams, diversions, and land use on the San Joaquin River have been more severe than on other Sierra Nevada rivers.

The snowmelt dominated hydrograph characteristic of larger Sierra Nevada rivers once supported spring- and fall-run Chinook salmon, and likely other anadromous fish species. While floods still occur on occasion under regulated conditions, most of the other natural hydrograph components have been eliminated, and in some reaches the aquifer has been severely depleted, water quality is poor, channel capacity reduced, and several reaches of the river are perennially dry. Sediment supply from the upper watershed has been eliminated, and the channel has been mined, confined, and bypassed. In one reach, the channel is indistinguishable from old sloughs, agricultural canals, and drains.

But anadromous salmonids can return, although the challenges will be considerable. Furthermore, improving healthy river function and the biota supported by that function faces many scientific and technical uncertainties. How do we reestablish a cold water anadromous fishery under highly regulated conditions that must migrate through a complex system of diversions, pumps, and flood bypasses? How do we rehabilitate geomorphic processes in a system with lower than average channel slope and sediment supply compared to other Sierra Nevada rivers? Answers to these questions will require additional predictive modeling, yet will also require more experimental releases and adaptive management. To provide the physical forces needed to restore natural processes, and consequently anadromous salmonid habitat, high flow releases will need to be re-operated. Solutions will also need to incorporate creative water operations, channel reconstruction, and other mechanical solutions. This presentation will summarize key uncertainties to restoring healthy river function on the San Joaquin River between Friant Dam and the Merced River confluence, focusing on those uncertainties most sensitive to water, infrastructure, land, and restoration costs.

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THE SERIAL ENGINEERING OF THE DELTA: CAN IT BE STOPPED?

The Sacramento-San Joaquin Delta has become one of the most highly-engineered estuaries of the Americas. For the past 150 years, interventionist approaches have dominated the extraction of ecosystem services from the Delta and its tributary watersheds. The over-dependence on structural and technological “fixes” to enhance ecosystem services has locked management into a cycle of serial engineering. Every engineered intervention appears plagued by the law of unintended consequences, creating an ever-escalating demand for more engineering fixes. With CALFED at a political and economic crossroad, it is reasonable to question whether this approach is sustainable.

The Delta is the regional archetype for serial engineering. The reclamation of more than 500,000 acres of tidal marsh involved the engineering of 1100 miles of levees, 1800 water diversions and 250 agricultural drain returns. The serial engineering challenges associated with this effort are well known, including managing the most subsided landscape in the world at the juncture of two large, flood-prone river systems. The second great ecosystem service engineered in the Delta—the CVP and SWP water supply pumps—created a cascade of serial engineering projects throughout the watershed. Use of the Delta for shipping, flood control, disposal of urban and agricultural runoff, and as a thermal dump for power plants has spawned demand for multiple fixes, both within and outside of the Delta. Even recreation--including fishing, hunting and messing around in boats--has its own unique suite of engineering efforts and unintended consequences.

Rather than waning due to its lack of success, the interventionist culture of Delta management is only growing, with new, more elaborate and more expensive proposals. This engineering approach is predicated on the assumption that conditions will remain the same. That is, historic imperfections in ecosystem services can be engineered out of the system in the future. Yet landscape change, including fundamental shifts in hydrologic conditions, subsidence, changes in land use activity and successive waves of non-native invaders makes the Delta a rapidly moving target, with prospects for even more dynamic conditions in the future. Institutional viscosity, limited resources and the reliance on the past as a predictor of the future limits our ability to keep up with the pace of change. The grand plans of today will be obsolete within a generation or two, demanding new, more fantastic engineering fixes. Breaking out of the cycle of serial engineering may involve making politically unpalatable decisions about which ecosystem services can be provided by the Delta and which will have to be curtailed.

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EVALUATING RESTORATION SUCCESS FROM THE PERSPECTIVE OF PLANTS AND ANIMALS

Evaluating success of tidal wetland habitat restoration is critical for several reasons. Understanding the ecological processes underlying marsh restoration as well as the pace of tidal marsh restoration can help restoration project engineers evaluate the design and implementation of future restoration projects and manage unexpected outcomes of restoration projects in progress. Regulatory agencies need to establish empirical, yet meaningful performance criteria for the purpose of permitting and evaluation. Restoration objectives for tidal marshes are often framed with respect to special-status wildlife, fish, and plant species with relatively narrow requirements for particular habitat structure, habitat dynamics, or specialized sub-habitats. Aligning tidal marsh restoration projects to achieve these requirements is important to justify to the general public major investment of public funds.

These competing objectives provide a challenge to the development of restoration success criteria. We outline a framework for developing restoration performance criteria that considers multiple spatial scales (local project, project complex, regional, and estuary-wide) and multiple temporal scales. We highlight a basic dilemma: mandated monitoring of restoration projects is generally short-term (< 2 decades, often c. 5 yr) yet the time course for achieving most important ecological objectives associated with mature marsh community structure is generally long-term (> 2 decades). We emphasize the importance of biological criteria that reflect restoration of ecological processes and community assembly, rather than mere presence/nondetection of target species. For example, for birds that breed in tidal marsh, desirable criteria include breeding density and achieved reproductive success at restoration sites. Finally, we recognize the need for cost-effective, efficient monitoring programs that can be sustained in the long-term, and the limitations of intensive but short-lived monitoring for these purposes.

Recent studies of restoring wetland sites indicate the ecological value of intermediate seral stages (transitional states of restoration sites). It is therefore valuable to develop success criteria that focus on evaluating young restoration sites, both to enhance the ecological value of such habitat and to provide early evaluation of restoration practice in a timely fashion, so that corrective steps may be taken. We use recent studies of restored and restoring tidal marshes to illustrate conceptual performance criteria that assess success on short-term and long-term scales and support management decisions regarding all phases of restoration projects.

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TOOLS FOR ASSESSING LANDSCAPE-SCALE HABITAT CHANGES IN WETLAND RESTORATION PLANNING

Tools that integrate system-wide physical and ecological processes can be useful for large-scale restoration planning by informing decisions about where, how much, and which types of habitat to restore. This presentation describes how integrated, landscape-scale tools can be used in restoration planning, drawing on an example from the South Bay Salt Pond (SBSP) Restoration Project in South San Francisco Bay. Successful design of this 15,100-acre project requires an understanding of how the ecosystem will evolve over time in response to possible management actions such as restoring tidal inundation to salt ponds to create tidal marsh.

The SBSP Landscape Scale Assessment is a geomorphic approach to predicting long-term (50-year) habitat changes within South San Francisco Bay without restoration as well as for different restoration scenarios. Given the inherent complexity of the processes involved, there are no standard “off the shelf” tools for this type of prediction. The assessment combines a sediment budget approach with existing analytical models, historical analysis, and empirical tools. The project planning timeline precluded development of new detailed models, such as a fine-grid numerical model, for the assessment. The physical-processes part of the assessment is an examination of the rate at which the restored South Bay salt ponds are expected to evolve from tidal mudflat to marsh, and how the restoration may affect the South Bay sediment budget and, ultimately, the extent of tidal mudflat and shallow-water habitats within the South Bay. The ecological part of the assessment uses the physical-processes results to predict vegetation, habitats, and wildlife use. Even when the large uncertainty inherent in this kind of assessment is considered, preliminary results suggest that sufficient sediment is available for tidal marsh restoration and that even the most subsided ponds are expected to provide tidal marsh habitat within the 50-year planning horizon.

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INDICATORS FOR SAN FRANCISCO BAY: "SCORECARD" UPDATE, NEW DEVELOPMENTS, AND LINKAGES TO REGIONAL AND NATIONAL EFFORTS

Large-scale ecological restoration programs across the nation are planning and developing suites of indicators or “report cards” to measure ecosystem condition. In October of 2003, the Bay Institute released the first comprehensive report card for San Francisco Bay. The San Francisco Bay Index or “Scorecard” is unique and innovative, interpreting science into clear and powerful publicly accessible messages. Nearly forty indicators were chosen based on a conceptual framework which ties condition to anthropogenic stressors. The indicators are aggregated into eight multi-metric indexes that track the Bay’s environment (Habitat, Freshwater Inflow, Water Quality), its fish and wildlife (Food Web, Shellfish, Fish), our management of its resources (Stewardship), and its direct value to the people who use it (Fishable-Swimmable-Drinkable). The Scorecard updated for 2005 (2003-2005 data), allows us to reflect on changes in ecosystem health. Condition appears to be slowly improving for physical resources; though impediments continue to plague our efforts to track progress. The Habitat Index, based largely on “tidal marsh restoration” response is showing a gradual upward trend reflecting restoration investments, but accurate reporting is still a challenge. Flow conditions and water quality also improved during the past two years, with the index grades slightly improving. For aquatic biota, we are not seeing the same improvement. The Fish index score is lower as population numbers (both abundance and sensitive resident pelagic species) continue to decline and the Suisun Bay food web has not risen from the low seen in the 2003.

This effort, despite its success is still evolving. Indicator development is an iterative process that depends on sound science and sustained support. Today, we continue as a coalition of national (SFEP) and local entities (TBI, SFEI, CEMAR) to refine, augment and improve upon the Scorecard concept. The Water Quality Index is being evaluated, refined and expanded upon to become a Contaminant Index that incorporates measures of Sediment Quality. The Fish Index is being evaluated by a larger team of researchers and improved by adding additional data sources. Wetland quality and bird resources are being evaluated for index development. Additional indicator development efforts are occurring at the California Bay Delta Authority and at the State level. Despite these efforts, progress is slow due to limited resources, outreach and politics.

Another challenge is to link our efforts to national indicator frameworks to ensure the representation and comparison of San Francisco Bay ecosystem health relative to other large-scale ecosystems. We compare the Scorecard with other regional and national indicator approaches to illustrate existing and suggest potential linkages. Across the nation, similar approaches exist, but there are important differences, which need to be addressed. These differences and the lack of a west coast focus in national efforts, points to the importance of our involvement in developing national-level ecosystem indicators.

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EVALUATING RESTORATION SUCCESS: THE HUMAN ANGLE

Most of the attention on habitat restoration projects is focused on the success or failure in producing the desired biological and physical results: achieving target populations of birds, fish, plants, etc. CALFED and others have long recognized that humans are a part of the ecosystem that must be considered as part of any restoration project, but in most projects, the human angle is not well-defined or considered.

In the South Bay Salt Pond Restoration Project, successful restoration must fully integrate the human element for a number of reasons. The most obvious reason is that the former salt ponds are literally surrounded by more than 2 million people. Restoration of the 15,100 acres of ponds that are now owned by the State and Federal governments must be carried out in a way that enhances the quality of life for residents of the South Bay area. This is particularly critical at a time when large-scale public funding is hard to come by.

Through its Stakeholder Forum and other processes the Project is working to identify what the broader community desires as a result of the restoration. Those broader public desires need to be considered within the constraints of Federal ownership (the Don Edwards San Francisco Bay National Wildlife Refuge) and State ownership (the Eden Landing State Ecological Preserve).

Equally important with the result is the process by which the restoration plan is developed. Transparency of decision-making is key to building public trust and support for the Project. This is true both in restoration planning and in long-term adaptive management. The Restoration Project is working hard to ensure that it earns that trust and support.

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AQUATIC COMMUNITY STRUCTURE AND PRODUCTIVITY OF A LARGE BRACKISH TIDAL MARSH IN THE UPPER SAN FRANCISCO ESTUARY: THE RELATIVE CONTRIBUTION TO THE ESTUARINE FOOD WEB AND INSIGHTS INTO RESTORATION BENEFITS.

Estuarine tidal marshes are productive habitats that provide the conditions and microhabitats necessary for successful invertebrate and fish rearing and recruitment. They may also provide, through export, a source of productivity to surrounding habitats. Tidal marsh habitat in the San Francisco Estuary (SFE) has decreased by 90% over the past 150 years. The impact of this loss and the ecological contribution of the remaining tidal marsh habitat in the SFE are not well understood. In this talk, we present recent findings from a CALFED-funded study investigating the productivity of tidal channels in Suisun Marsh, Solano County, the largest contiguous brackish tidal marsh on the West Coast of the United States. These findings are compared and contrasted to data collected by the California Department of Fish and Game in adjacent bay and river habitats (Neomysis and Zooplankton Surveys). Primary production, as measured by Chlorophyll a, indicates several regions of high productivity within the interior of the marsh, likely due to high residence time of water, nutrient availability, and absence of alien clams. Surrounding bay and river channel habitats had very low levels of primary production. Invertebrates, including mesozooplankton and benthos are most abundant within the interior sloughs and channels, often reaching very high densities. Macrozooplankton abundance patterns are more variable, but are also high within the marsh interior and rivers with declines observed in some bay and large slough habitats. These data suggest that Suisun Marsh plays a significant role in estuarine productivity by providing an abundant source of primary production and pelagic invertebrates, both of which are significantly depleted in bay and river channel habitats. These localized areas of high productivity may transfer benefits up the food chain, as fish abundance for select species remains high in the tidal marsh sloughs despite considerable declines observed elsewhere in the SFE. There is little evidence that this productivity is directly transported to the exterior bay and channel habitats, although migratory invertebrates and fish may export considerable quantities of biomass from the marsh through their movements.

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STEWARDS AND SCIENTISTS: THE IMPERATIVE FOR COLLABORATION

For most of my professional career I have attempted to identify, develop, and apply strategies to facilitate the collaboration of scientists with decision-makers, and stakeholders that are so critical to environmental sustainability. I will describe the model that has emerged over more than three decades as a student and practitioner. I will discuss those who have influenced the evolution of this model and how.

The model is an "environmental decision value chain" and has the following elements:

- Proper valuation of the resources at risk
- A regional approach to finding solutions that is
    - Scalable to fit the issues
    - Inclusive and transparent
    - Futuristic in its orientation
- Key to it all are
    - Functional institutional mechanisms at the regional level, and
    - An informed, involved, concerned public

The investments of hundreds of millions of dollars in major coastal "clean-up and restoration initiatives" too often have failed to meet stated goals and stakeholders' expectations. It is clear that new institutional mechanisms are needed. There is a better way.

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LONG-TERM, LARGE-SCALE WETLAND MONITORING IN THE SF ESTUARY: NEEDS AND PROSPECTS

Are we giving migratory birds more and better habitat? Are fish getting more food from productive marshes? Do we have more connected parcels reflected in greater overall species support? The only way to know is to monitor natural and restored wetlands beyond status and trends to data collection designs based on cause and effect models and scalable from sites to sub-regions to the Estuary. With monitoring, we can evaluate our past investments in resource restoration and management, prioritize and carry out the most effective future restorations, address potential problems, and support regional planning. Weaving science into estuarine management demands that we evaluate past investments, rebalance the focal point of our political capital when we learn what is more effective, and be prepared for surprises with early warnings of potential problems. At present, the San Francisco Estuary has no long-term, large-scale wetland monitoring in place, though several separate efforts contribute key elements.

Needs. Monitoring is more than collecting data on status and trends – it is analyzing, integrating, applying, and distributing information. **Need #1:** distribute monitoring results *widely and easily* via the internet to facilitate their utility. **Need #2:** continue to develop unbiased *lessons learned* from older and more recent restorations; restoration evolution demands revisiting older projects periodically as lessons can change after project-specific monitoring ends. **Need #3:** conduct field- and laboratory-based problem evaluation monitoring to support problem resolution. **Need #4:** conduct periodic regional assessments combining remote sensing with focused rapid field assessments to inform regulatory program effectiveness and support planning initiatives. **Need #5:** finish protocols for data collection, QA/QC, and analysis and develop *decision trees* for selecting protocols applicable to the many circumstances we encounter, so we do not keep reinventing the wheel and so that we have confidence in data. **Need #6:** for regional and sub-regional efforts, include: conceptual models explaining how what you are monitoring is linked to things that could change; monitoring data (QA/QC, storage, and public access), a data analysis sub-program (looks for trends, patterns, covariance, and frames the "why" research), a research sub-program (tests the conceptual models and explains why you see what you do), and identifies clear, agreed upon goals and management questions amongst funders and major customers.

Prospects. Funding is the major impediment: monitoring typically costs more than "desired" and decision makers often do not place high value on monitoring especially with competing demands for implementation dollars, leaving us not knowing whether "build it and they will come" is true and, if so, why. **Lack of collaborative governance:** many and divergent views exist about monitoring and restoration; currently, no forum exists to address and resolve those views. **Centralized information availability: a**ggregating results in a publicly accessible manner has not occurred, though a structure now exists (www.wrmp.org) that awaits a significant information upload effort.

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FOOD WEB SOURCES AND PATHWAYS IN RESTORING TIDAL WETLANDS: WILL THEY BENEFIT THE BAY?

Understanding food webs in complex estuaries such as San Francisco Bay requires a comprehensive knowledge about how heterogeneity of the estuary creates subsystems or compartments of interacting food web sources and consumers. This should especially be the case when we are trying to predict or evaluate the potential role of restoration actions. The dominant base of our knowledge about the food web structure of San Francisco Bay is founded on a phenomenal accumulation of knowledge about open water, pelagic food webs based on phytoplankton—the “classic” food web of Hardy (1924). Even the complexities of the heterotrophic/microbial aspects are focused in the pelagic realm. The paradigm is that the Bay “runs” on phytoplankton.

However, there are shallow water and wetland ecosystems that once comprised, and now and could in the future comprise a significant compartment in the Bay’s food web, that likely integrates with the pelagic compartment. Recent research using both traditional methods (food habits) and conservative biomarkers (stable isotopes) indicate that tidal emergent marshes not only support closely-coupled internal food webs but also provide linkages to the open Bay through direct and indirect exchanges of transient consumers and very likely organic detritus. Contrasting marsh residents (e.g., benthic invertebrates such as *Macoma balthica*, *Corophium* spp., and *Ischadium demissum*; Pacific staghorn sculpin, yellowfin goby, Shimofuri goby, threespine stickleback, tule perch, rainwater killifish) and nursery residents (e.g., splittail, Chinook salmon) with more transient planktivores (e.g., Sacramento splittail, northern anchovy, Pacific herring, inland silversides, topsmelt) and predators (e.g., striped bass) indicate that autochthonous production dominates the emergent wetland food webs but that they also contribute to the broader Bay food web. Evidence from stable isotope analyses suggest that both edaphic microalgae and emergent marsh macrophytic organic matter contribute significantly to transient species, while phytoplankton is a comparatively minor contributor. The highly dynamic nature of these food web “loops” is evident from the variability in contributions of organic matter sources, often tied to consumer life histories and behaviors, as well as responses to disturbance events, such as freshwater flooding.

A more integrated, “intercompartmental” and dynamic view of San Francisco Bay-Delta food webs would enhance our ability to understand both the basis of and variability in support of important consumer organisms as well as the comprehensive role of wetland restoration in the Bay-Delta.

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WHERE HAVE ALL OF THE PELAGIC FISHES GONE?

Abundance indices calculated by the Interagency Ecological Program (IEP) suggest recent marked declines in numerous pelagic fishes (delta smelt, longfin smelt, threadfin shad and striped bass) and their zooplankton prey (calanoid copepods) in the Delta and Suisun Bay through 2004. Initial statistical analyses of the data for these pelagic species indicate that there are statistically-significant long-term declines in the Delta/Suisun Bay, and evidence of a recent step-change. Similar analyses for the fishes of the San Francisco Bay showed no clear decline. Recent abundance estimates for the summer townet survey suggest that low delta smelt abundance has continued in 2005.

The low levels of Delta/Suisun Bay pelagic species are unexpected given the relatively moderate hydrology over the past three years. Our conceptual model includes at least three general factors that may be acting individually or in concert to lower pelagic productivity: 1) toxins; 2) invasive species; and 3) water project operations. IEP has undertaken an interdisciplinary, multi-agency study effort to evaluate these stressors. The overall approach for 2005 is based on a “triage” model to identify the most likely causes, and to assign priorities to projects on the basis of where funds and resources can be best used. The proposed work falls into four general types: 1) an expansion of existing monitoring (four expanded surveys); 2) analyses of existing data (nine studies); 3) new studies (six studies); and 4) ongoing studies (four studies).

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TYING ALL THE LOOSE ENDS TOGETHER: WHERE DO WE GO FROM HERE?

The State of the Estuary Conference provides an exciting forum where scientists, government officials, policy makers and the public can come together to discuss what has recently been learned about the Bay ecosystem, what mysteries remain and how to advance strategies aimed at better protecting and enhancing the natural resources of the Bay. Advocacy for the Bay is critically important. But to a large degree advocacy alone ignores the fact that what happens to the Bay is intrinsically linked to what happens upland and upstream of the Bay. To be effective, any strategy for improving the Bay has to acknowledge the realities of gravity, economic forces, politics and the broader needs of society in the Bay Area.

To a large degree, if current practices are continued, the future of the Bay Area rests on the outcome of a race between two forces. The first wants to protect the Bay Area’s natural resources by buying property and by limiting development through government regulatory programs. The second wants to provide housing and jobs for Bay Area residents by securing property and development entitlements and by limiting government’s regulatory authority.

Despite the adversarial nature of the two forces in this race, each side has much to gain by helping the other side succeed. As the region’s economy continues to transition toward tourism and services that rely on a highly-skilled and innovative workforce, a beautiful environment and “quality of life” amenities, such as clean water, pure air, parks and open space, are investments that have positive economic payoffs. On the other hand, even though in opinion polls show the public says it is willing to sacrifice economic growth to protect the natural environment, the same polls find that the public views congestion, education, crime and housing costs as more important issues than environmental protection. Therefore, to sustain public—and political—support for their cause, it would seem wise for environmentalists to contribute to the solution of those problems the general public regards as being of greatest importance.

There have been few efforts—and none that have been fully successful—at bringing these two forces together to develop an overall regional plan that would protect critical natural resources, provide adequate and affordable housing and advance needed job growth. But it is time and essential to try once again because the Bay cannot truly be saved if the Bay Area does not enjoy environmental, economic and social prosperity.

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THE ROLE OF SCIENCE IN GUIDING RESTORATION DESIGN AND ADAPTIVE MANAGEMENT

The Science Program for the South Bay Salt Pond Restoration Project provides direct scientific input into planning for short-term and long-term Project actions. The Project's Science Team has worked to identify key scientific uncertainties associated with the Project and, through technical workshops and focused literature reviews, has collated information on what is known and not known about these questions. Using this information, as well as material developed by the Consultant Team and Stakeholders, the Science Team drafted an Adaptive Management Plan (AMP) for the Project. This talk presents the elements of the draft AMP and illustrates how monitoring and applied studies, beginning now in the planning stage, can be used to address uncertainties. The data produced during planning will be applied directly in the design of Phase 1, to be implemented beginning in 2008. The draft AMP also describes how adaptive management will be integrated into Project implementation to track the Project's ecological and social goals and collect data to address key questions. As adaptive management reduces uncertainty, future phases of the Project can move forward with more information. Thus, implementing adaptive management is central to guiding the design and success of the Project.

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CLIMATE CHANGE IMPACTS ON THE SAN JOAQUIN RIVER BASIN: EVIDENCE FROM THE HISTORIC RECORD AND PREDICTIONS FOR THE FUTURE

Climate change has the potential to impact hydrology and water resources throughout the world. Some regions, like California Sierra Nevada Mountains are especially vulnerable to these impacts due to its dependence on mountain snow accumulation and the snowmelt process, two processes especially susceptible to changes in temperature. This potential risk, looks even more relevant if we consider changes in the timing of streamflow that are already happening in the California Sierra Nevada Mountains as suggested by various studies.

The prediction of future climate change impacts on California hydrology and water resources is based primarily on the use of General Circulation Models (GCMs), which predict future changes in temperature, precipitation and other climatic variables based on the interactions between the land, atmosphere and oceans. Hydrologic models then use these changes to predict climate change impacts on natural runoff. Finally, water resources models are used to transfer these changes in natural runoff into changes in water deliveries and impacts to the water resources systems. There have been a vast number of research activities in the last 20 years that have attempted to assess the impacts of climate change on the California hydrology and water resources systems. These studies have used different GCMs and hydrologic or water resources models at various levels of complexity, but all of them consistently predict a change in timing in streamflow runoff due to a consistent increase in temperature. However, changes in the winter runoff are still uncertain, mainly due to uncertainties in precipitation predictions. The message taken from these studies is simple: there will be more water when we don't need it and less when we need it.

When comparing the relative impacts of climate change for different regions in California, most of these studies have shown that the impacts will be higher in the northern (e.g. American River) than in southern (e.g. Merced River) Sierra Nevada Mountains. This is a result consistent to measured historical streamflow trends and relates to the relative altitude of basins located in these two regions (the high altitude basins in the southern Sierra Nevada Mountains being less affected by increases in temperature). However, recent modeling results suggest that an opposite effect might happen, i.e. impacts could be much higher in the southern as compared to northern Sierra Nevada. The reasons behind these contradicting results are higher temperature predictions by latest GCM runs and almost neutral changes in precipitation.

Using these latest GCMs results to run a hydrologic model (VIC) and a water resources model (CalSim) for California, we show that these changes will potentially affect the performance of the infrastructure in the San Joaquin River basin, limiting its availability to meet all water resources objectives, like water deliveries, energy generation and environmental services in the Bay Delta and San Joaquin river.

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CHALLENGES OF THE SAN JOAQUIN

The San Joaquin River runs through a region that is rapidly changing. Within the last 150 years, the region was transformed from a place characterized by seasonal wetlands, deep tules and roaming grizzly bears, into one of the richest agricultural areas in the world. Now changes are flowing again, this time from different sources. Waves of new residents - Immigrants from faraway places, migrants from the Coastal parts of California, and babies everywhere - are swelling the population at a growth rate that exceeds that of the country of Mexico. People come to the Valley to seek affordable housing and new opportunities. Some have created a false dichotomy between the protecting the environment and economic well being. The short term response most often opts for the economy over the environment. The environmental health of the entire San Joaquin Valley will depend in part on local politics as well as on the engagement and attention of the rest of the State. Those who live in the region see resources in abundance and don't understand their value to the world. Those who are often in the best position to protect and conserve resources are often resentful of having to make economic sacrifices for others, whose economic well being is already secure and is not limited by the environment. Finding fair and balanced ways to meet all the legitimate needs of this growing and changing region is not impossible - its just darn hard!

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SOUTH BAY RESTORATION: BAIR ISLAND, EDEN LANDING AND SOUTH BAY SALT PONDS

Over the last several years, significant progress has been made toward preservation and restoration of tidal wetlands in the South Bay. With the Cargill Salt Ponds acquisition 17,700 acres of diked former Baylands are in the planning process of being restored. These projects include the Eden Landing Restoration Project, Bair Island and the South Bay Salt Ponds. These projects build on restoration efforts over the past 30 years which have resulted in substantial tidal wetland restoration in the South Bay.

The Baylands Ecosystem Habitat Goals Report recommended the restoration of between 16,000 and 21,000 acres of tidal marsh habitat in the South Bay and the management of 10,000 to 15,000 acres of salt pond habitat. With the current projects the objectives for tidal marsh restoration may be achieved within the foreseeable future.

The Eden Landing Restoration Project is currently under construction and is scheduled to be completed in the summer of 2006. This project will restore 650 acres of former crystallizers and salt ponds to tidal marsh while enhancing the management of an additional 200 acres of managed ponds. One element of the project will be the restoration of approximately four miles of large tidal channels.

The Bair Island Restoration Project is currently in the final stages of planning and permitting. This project will restore approximately 1,700 acres of diked Baylands to tidal influence. The timing of restoration is being coordinated with nonnative Spartina control efforts to minimize the potential for colonization once restoration is implemented. The project will also use dredge material to accelerate tidal marsh development to minimize potential bird strike concerns associated with the nearby San Carlos Airport. Tidal barriers will also be installed in two major sloughs to address potential sedimentation concerns at the Port of Redwood City.

The South Bay Salt Ponds Restoration Project is developing the restoration plan for the 15,100 acres of salt ponds acquired from Cargill Salt in 2003. This planning effort will be completed and a first phase restoration project implemented in 2008. In the interim, the Department of Fish and Game and U. S. Fish and Wildlife Service are managing the ponds under an Initial Stewardship Plan. Implementation of this plan has resulted in substantial increases in wildlife use, but also highlights the complexity of managing large ponds to maintain compliance with water quality objectives.

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DELTA PERSPECTIVE ON THE DELTA IMPROVEMENT PACKAGE

The Delta Improvement Package, or "DIP", is a CalFed proposal which is based upon an integrated regional management plan which grew out of stakeholder negotiations which formed the basis of HR 2828, the federal reauthorization bill for CalFed. Environmental interests were notably absent in the negotiations, and the whole process preceded recognition of the precipitous decline of the pelagic fishery in the Bay-Delta system.

Nevertheless, the DIP recognizes and includes topics which must be addressed to improve water supply and quality issues in the Delta and in the Lower San Joaquin River which have resulted largely as a result of water export operations:

- Water quality at sensitive diversion points in the Delta
- Water supply and channel level sufficiency at sensitive diversion points in the Delta
- Upstream water quality and flow in the San Joaquin River below the mouth of the Merced River
- Drainage regulation from farmlands and wildlife refuges in the San Joaquin Valley
- Levee protection in the Delta

Correction of these existing problems, and avoidance of any aggravation, are conditions of any increase in allowable export levels. Similar protections for fish and wildlife resources must be developed through the NEPA-CEQA process applicable to the DIP, recognizing that much of the burden of addressing these issues falls upon the exporters as mitigation responsibility for problems created or aggravated by the exports.